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RICE PRODUCTION IN THE SOUTHERN STATES

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RICE is the principal cash cereal crop grown on the prairies of southwestern Louisiana, southeastern Texas, and on the Grand Prairie and other sections of eastern Arkansas. The crop is grown on relatively level soils that hold water well, and, at reasonable cost, can be prepared for irrigation and provided with fairly good surface drainage. In the 5-year period 1945–49 about 79 million bushels of rice was produced annually in the United States. In this period about 78 percent of the crop was produced in the Southern States and 22 percent in California.

A dependable and adequate supply of fresh irrigation water is necessary to grow rice efficiently. The levees that divide the field into subfields, or "cuts," should be well constructed on contours and of sufficient height to hold an average depth of 5 inches of water on the land.

Rice is generally sown between April 1 and May 30. Soon after the seedlings emerge the land is submerged gradually with water 4 to 6 inches deep. Usually the land is drained about 2 weeks before the crop is mature.

Most of the crop is harvested with combines, dried artificially, and stored in bulk. That harvested with binders is shocked and then threshed after it has cured in shock from 10 days to 2 weeks. The grain is stored in bulk or in sacks on farms or in public elevators and warehouses until sold to mills.

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RICE PRODUCTION IN THE SOUTHERN STATES

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Contents

RICE PRODUCTION in the United States is centered in four States—the three Southern States of Arkansas, Louisiana, and Texas, and in California. In many counties and parishes of these four States rice is the principal cash crop (fig. 1).

In the 5-year period ending with 1949, Louisiana produced about 30 percent of the annual crop, Texas 26 percent, and Arkansas and California each 22 percent.[1] The United States produced about 1.1 percent of the world's supply of rice in the crop year 1948–49. An average of about 6 pounds per person was consumed in 1949. In 1948–49 about 94 percent of the world's rice crop was produced in Asia. The principal rice-producing countries outside of Asia are Italy and Spain in Europe, Egypt and Madagascar in Africa, and Brazil and the United States in the Western Hemisphere.

Areas of production in the four principal producing States are: (1) The broad level prairies of southwestern Louisiana and southeastern Texas, which are irrigated with water pumped from streams and wells; (2) the Grand Prairie and other sections in eastern Arkansas, where irrigation water is largely pumped from wells, although some water from reservoirs is used; and (3) the Sacramento and San Joaquin Valleys of California, where irrigation water is obtained by gravity and pumps, largely from the Feather and Sacramento Rivers or from wells.

[1] Some rice is also produced commercially in Missouri, Florida, and Mississippi.

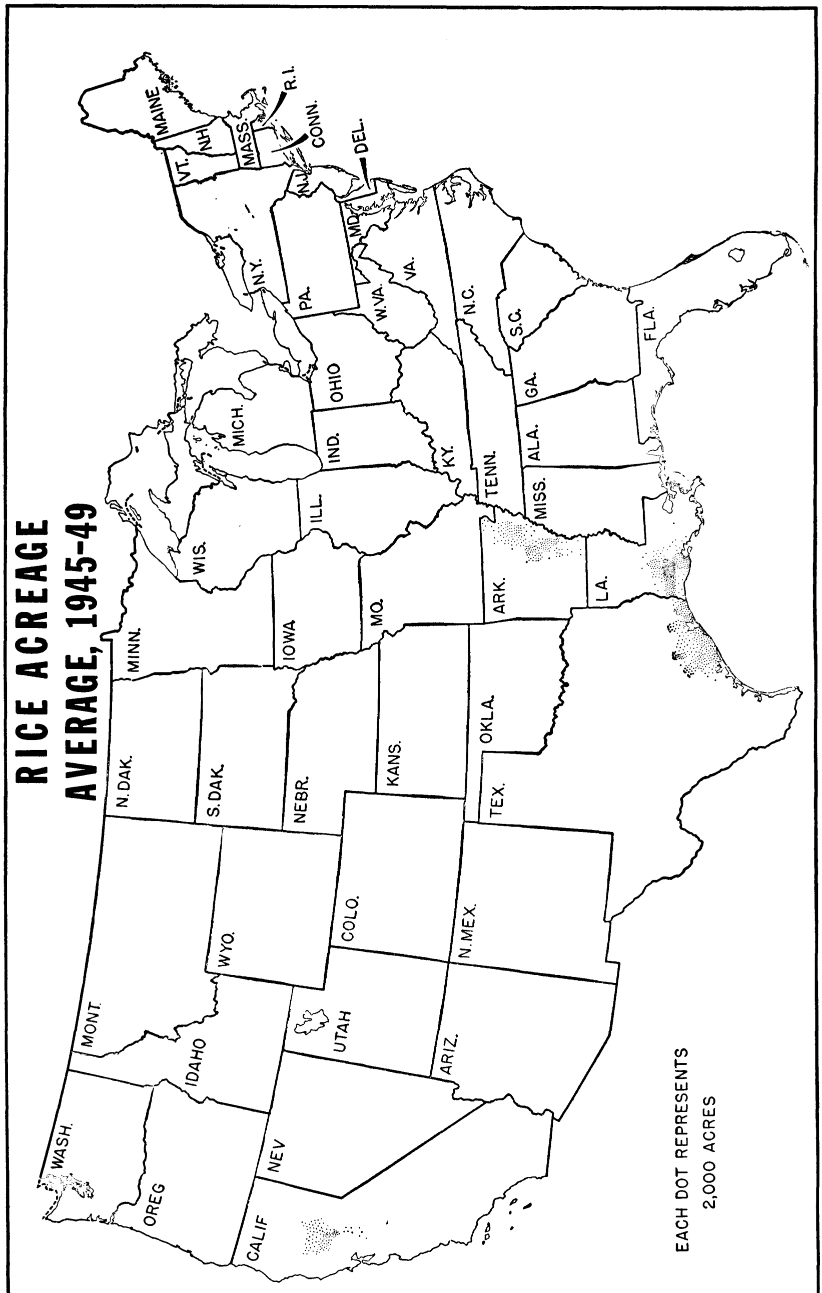

Figure 1.—Rice areas in the United States, 1945–49.

This publication deals primarily with rice production in Arkansas, Louisiana, and Texas. Also treated in this publication is the commercial production of rice in the Teche Bayou and the Mississippi River areas of Louisiana, where the crop is produced with slightly different cultural practices (see p. 31).

The production of rice in California is not included in this bulletin. For rice production in this State, see Farmers' Bulletin 2022, Rice Production in California.

HISTORY

Rice was introduced into the colony of South Carolina at or near Charleston, probably from Madagascar, in about 1685. In 1859 South Carolina, North Carolina, and Georgia produced about 90 percent of the rice grown in the United States, and South Carolina alone produced about 60 percent of that grown. This crop was affected adversely in the South Atlantic States by the War Between the States, and production declined thereafter. About this time the rice acreage increased along the Mississippi River in Louisiana, but the crop did not become important in this State until 1887, when mechanized methods were introduced on the prairies in the southwestern part.

Upland, or nonirrigated, rice probably was grown to a small extent in Texas as early as 1863; however, the crop did not become of commercial importance on irrigated land until 1899, when 8,500 acres were grown in the Beaumont district of Jefferson County in southeastern Texas. In 1902 rice was grown on a small acreage on the Grand Prairie of Arkansas, and commercial production began the following year. In 1889 Louisiana became, and still was in 1949, the leading State in rice production. In California the first commercial rice crop was grown near Biggs, in the Sacramento Valley, in 1912.

REQUIREMENTS OF THE CROP

Climate

In the United States the production of satisfactory rice crops is dependent upon (1) high temperatures, especially relatively high mean temperatures, during the growing season; (2) a dependable supply of fresh water for irrigation; (3) soils that are comparatively level and hold water well because of a tight soil or subsoil through which loss by seepage is small; and (4) good surface drainage.

These conditions prevail on the coastal prairies of southwestern Louisiana and southeastern Texas and on the Grand Prairie and other sections in eastern Arkansas. In these sections the summers are warm and sultry and the daily maximum temperatures usually range from 90° to 100° F. Mean temperatures in late spring and early fall are about 70°, and in summer about 82°. The average annual precipitation ranges from 50 to 57 inches, and it is well distributed during the growing season.

Soils

The rice crop in the Southern States normally is grown on medium to heavy soils, which are more economical in the use of water and, when drained, support harvesting machinery better than do lighter soils. In Louisiana and Arkansas a large acreage of rice is grown on Crowley silt loam, which holds water well. This soil is rather heavy and compact and when plowed wet is likely to puddle. Rice is also grown in these States on lighter soils underlain by relatively impervious subsoils. In Texas, Beaumont and Lake Charles clays are typical heavy soils on which the rice is grown. The crop is also grown on lighter soils that hold water well. As a rule, it is more difficult to prepare satisfactory seedbeds on heavy than on lighter types of soil.

Sources of Irrigation Water

Irrigation water for rice production in Louisiana and Texas is obtained from sluggish streams, which pass through the prairie en route to the Gulf of Mexico, and from wells. Privately owned companies and other agencies provide the water, which is lifted from streams by pumps and distributed in canals (figs. 2 and 3). In some wells near the Gulf water stands near the surface of the ground, but inland from the Gulf the water level ranges from 25 to 50 feet or more below the surface. Inland wells vary in depth from 350 to 400 feet or more. Although many wells are used every year, others are operated only when there is a shortage of fresh surface irrigation water in canals. In 1949 more than 40 percent of the rice acreage in Louisiana and probably from 15 to 20 percent or more of that sown to rice in Texas (fig. 4) were irrigated from wells. About 40 to 45 inches of water are required to produce a crop in this region, of which approximately 15 inches are supplied by rainfall during the growing season. Irrigation water is supplied to farmers on a crop rental or cash basis.

In Arkansas most of the irrigation water is obtained from wells owned by the farmers. The water level ranges from 30 to 90 feet

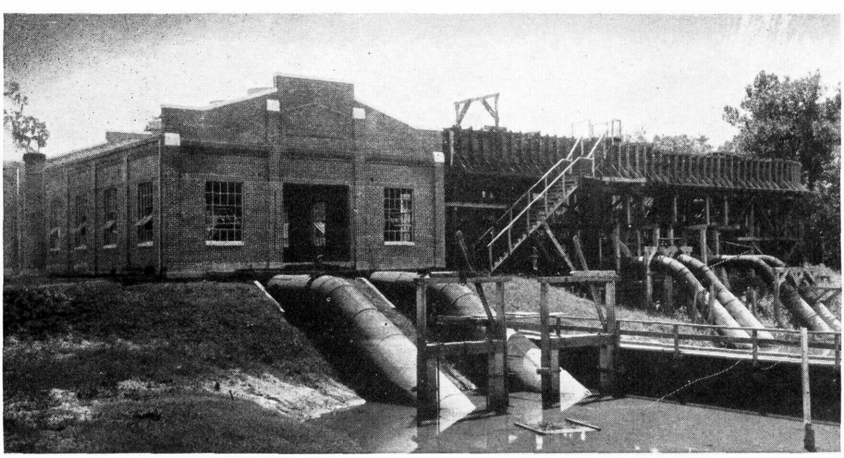

Figure 2.—*Intakes for modern irrigation pumps.*

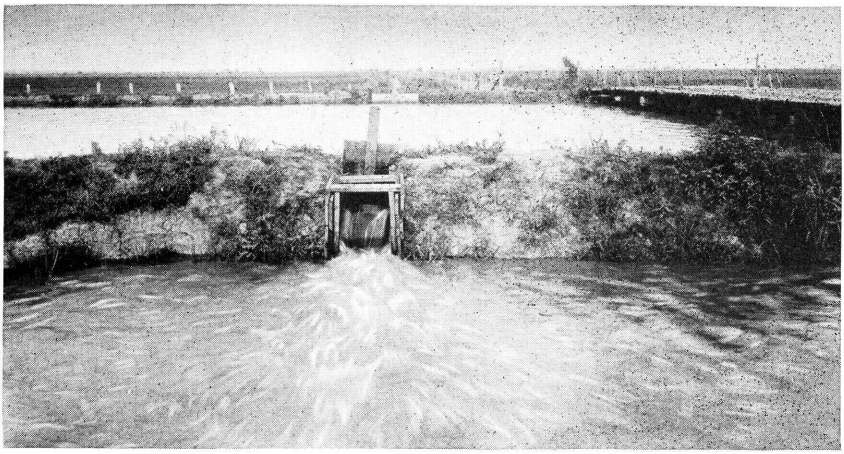

Figure 3.—*A floodgate through which water passes from the main irrigation canal into smaller canals and then into the fields.*

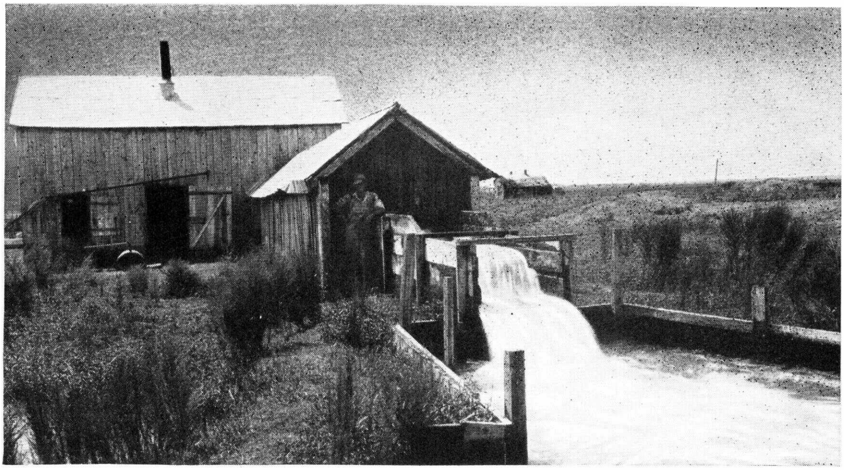

Figure 4.—*Water being discharged from a well.*

or more below the surface of the ground. The capacity of the pumps needed depends upon the acreage to be irrigated. The average recommended capacity of the pump is a delivery of 1 cubic foot a second, or 450 gallons of water a minute, for each 80 acres irrigated. It requires about 33 inches of water to produce a crop on the relatively impervious soils of the Grand Prairie, of which about 11 inches is supplied by rain during the growing season.

PREPARATION OF LAND FOR IRRIGATION

Most of the land on which rice is grown in the Southern States is comparatively level, with a gentle slope toward drainage channels. The preparation of such lands for irrigation is usually not too expensive.

A competent surveyor is employed to locate the canal and drainage ditches and the field levees. Improper location of ditches and levees may cause serious losses, owing to faulty irrigation and poor drainage. Irrigation ditches should be large enough to supply ample water promptly when needed, and the drainage ditches should likewise have sufficient capacity to dispose of water promptly (fig. 5).

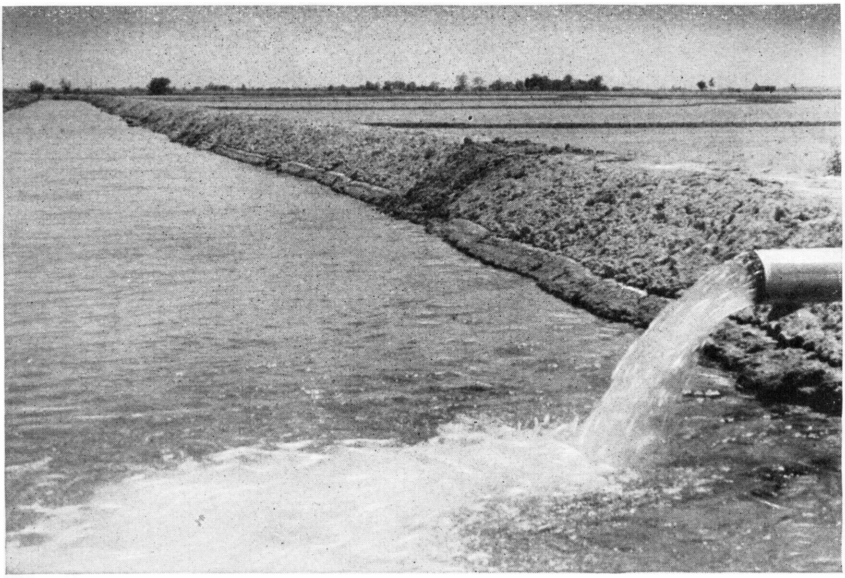

Figure 5.—*Water being discharged into an irrigation canal.*

Figure 6.—*Constructing a levee base with a disk plow.*

Levees that divide fields into subfields, or "cuts," are located on contour lines (fig. 6). The difference in elevation between adjacent contour lines is usually about two-tenths of a foot or less. Leveling the land prior to surveying results in a more accurate location of the levees and the holding of a more uniform depth of water on the subfields, which gives better control of weeds and grasses. In Texas and Louisiana double pushers (fig. 7, *A*) and, to some extent, steel pushers on wheels are used in constructing levees; whereas, in Arkansas levee disks (fig. 7, *B*) and pusher-type implements are usually used. When possible the levees should have gently sloping sides and be high enough to hold an average depth of 4 to 6 inches of water on subfields without the water overflowing into the next lower field. Seeding and harvesting machinery can pass readily over levees of this type without damage to them or the machinery. Sloping levees reduce the cost of seedbed preparation, of seeding, and of harvesting, because each field can then be worked as a unit. Levees of this type are also seeded and produce considerable rice, thereby reducing the growth of weeds. If

Figure 7.—*Constructing a levee with a pusher (A) and with a levee disk (B).*

high, narrow levees are used or the rice on levees fails to ripen at the same time as that in the fields, each subfield can be harvested separately.

Compact levees reduce seepage. Levees may be partly constructed during winter and early-spring months, in order that they may have time to settle before seeding and irrigation. All newly constructed levees settle considerably, and they should be built nearly twice as high as is necessary to hold the water at the desired level. Well-constructed levees, properly repaired after seeding, facilitate irrigation and eliminate much expensive hand-shoveling when the fields are submerged.

Irrigation water normally is delivered by ditches, canals, or pumps to the highest subfields in a field, and it passes into successively lower subfields through openings in the levees. Openings in the levees are closed when the desired depth of water is attained in the field. Overflows are constructed that help prevent breaks in levees when heavy rains occur. Because of variations in irrigation, water supply, and rainfall, some fluctuation in the depth of water held on a field is unavoidable.

ROTATION

In Louisiana and Texas rice is largely grown under conditions that make it difficult to follow a definite system of crop rotation. In order to grow cultivated crops conveniently in rotation with rice the levees usually are broken down and then reconstructed for the following crop. This involves considerable expense. Furthermore, other cultivated crops often are not profitable. Rice, however, is not grown continuously on the same land. The most common practice is to grow one or two rice crops and then pasture the land for 1 to 3 years before using it for rice again. The land is materially improved in physical condition by the accumulation of organic matter in the surface soil during the grazing period. Rice soils, as a rule, are deficient in organic matter, because high temperatures and available moisture lead to a rapid decomposition of organic materials incorporated in the soil. For this reason a rotation of rice and improved or native pastures appears to be the best cropping system (fig. 8). The rotation of rice with improved pastures enhances the productivity of the soil, increases rice yields, and provides much better grazing for beef cattle than do unimproved pastures. Unimproved pastures, however, apparently are more commonly used. In some cases rice is grown in rotation with clean fallow, cotton, soybeans, peanuts, corn, and green manures in Louisiana and Texas.

In Arkansas, on rice farms studied in 1947, approximately one-half of the land was sown to rice. A fourth was idle pasture or fallowed, and the remaining fourth was cropped to oats, soybeans, lespedeza, corn, or cotton. Oats are grown rather extensively in the rice area, for the crop is harvested with available rice equipment. Oats and soybeans are grown largely as cash crops. However, some oats are fed to livestock, and occasionally soybeans are turned under as green manure. Lespedeza usually is grown after oats as a seed crop, pasture, and green manure. Corn and cotton are of only minor importance in the rice area.

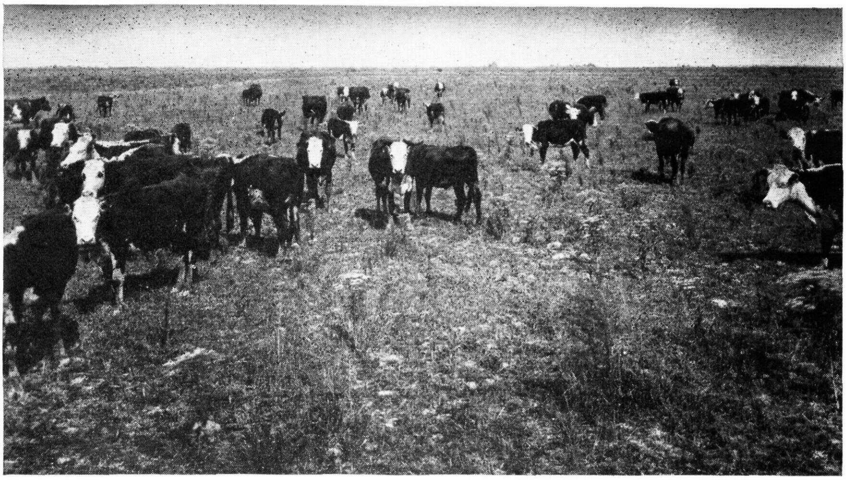

Figure 8.—*Cattle grazing on native pasture.*

PREPARATION OF THE SEEDBED

In preparing the seedbed for rice the aim is to destroy weeds and obtain a mellow, firm surface layer in which the rice can be sown to the desired depth under conditions that are favorable for quick germination and normal seedling development. The land should be plowed 4 to 6 inches deep (fig. 9). In Louisiana and Texas early-fall and winter plowing of riceland is common, but in Arkansas most of the land is spring-plowed. In Louisiana and Texas the plowed land may be disked in January or February if weather conditions are favorable.

Figure 9.—*Plowing land for rice.*

Fall- and winter-plowed land is normally left in the rough and provided with surface drainage until the following spring. If the land is reasonably well drained, the frost and winter precipitation mellow the plowed land. Usually by spring a good seedbed can be prepared by disking, harrowing, and floating (dragging) (figs. 10 and 11). On poorly drained land more difficulty is experienced in preparing a suitable seedbed and replowing may be necessary. Land leveling, with land planes and other levelers, is increasing in importance in order to improve irrigation, surface drainage, stands, and uniformity in plant growth and maturity and to facilitate harvesting operations (fig. 12).

Figure 10.—*Disking plowed land in seedbed preparation.*

Rice stubble and weed growth, plowed under, decompose readily in the fall and winter if proper drainage is provided. This decomposition aids in the preparation of a good seedbed. In Arkansas, stubble land and land with a heavy vegetative growth may be floated to aid plowing and the decaying of organic material. The number of times it will be necessary to disk, harrow, and float depends upon drainage and the condition of the soil.

Spring-plowed land ordinarily should be disked and harrowed immediately after plowing to prevent baking and subsequent difficulty in seedbed preparation. Heavy soils usually require more subsequent tillage to obtain a good seedbed when spring-plowed than when plowed in the winter, but light soils usually can be prepared comparatively easily after either winter or spring plowing.

In a good seedbed the surface soil is reduced to a mellow, firm condition, moisture is held near the surface, and germination usually occurs promptly after seeding without irrigation.

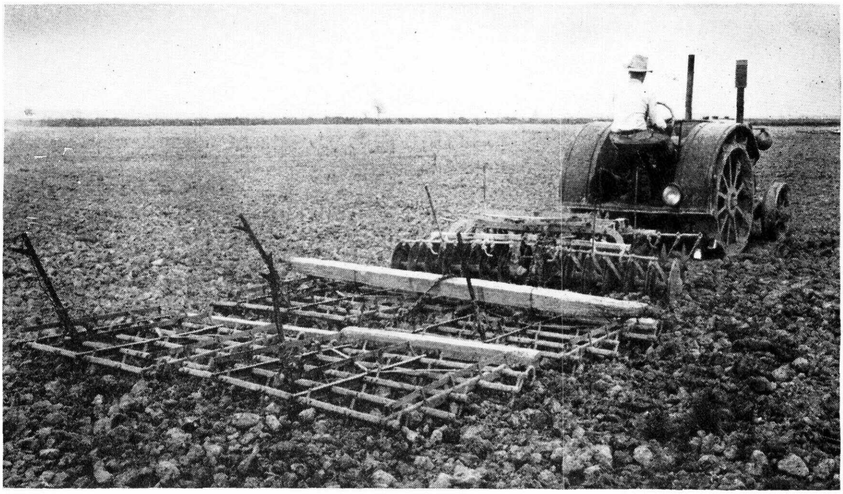

Figure 11.—*Disking and harrowing in seedbed preparation.*

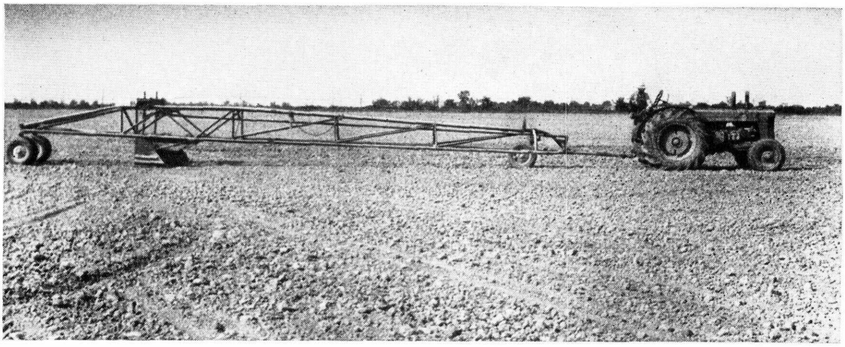

Figure 12.—*A land leveler in operation.*

On foul land where weeds and grasses are a problem, it is important to get the rice up immediately after seeding, if possible, so that such pests can be controlled. For this reason if sufficient moisture is not available in the seedbed to induce germination at seeding time, the rice is often sown shallow and flushed (irrigated) immediately.

VARIETIES GROWN

In the principal rice-producing countries of the world, varieties are often grouped as lowland (irrigated) and upland (nonirrigated) types. Lowland (irrigated or rain-fed) varieties can be grown without irrigation, but under such conditions are less productive than when grown with irrigation. Upland (nonirrigated) varieties usually are more productive when grown under irrigation than when grown without irrigation but are less productive than the better lowland varieties (see Upland Rice, p. 32). The words "lowland" and "upland" do not

refer especially to elevation; lowland varieties are grown on terraced hillsides as well as on lowlands, and upland varieties may be grown without irrigation on uplands and lowlands.

In the commercial rice-producing sections of the Southern States only lowland, or irrigated, varieties are grown, including short-, medium-, and long-grain types. The plants at maturity vary in height from 36 to 58 inches. The average length of the kernel (hulled rice) of the short-grain rice is 5.5 millimeters, that of the medium-grain 6.6 millimeters, and that of the long-grain 7 to 8 millimeters (fig. 13). One millimeter is equal to about one twenty-fifth of an inch.

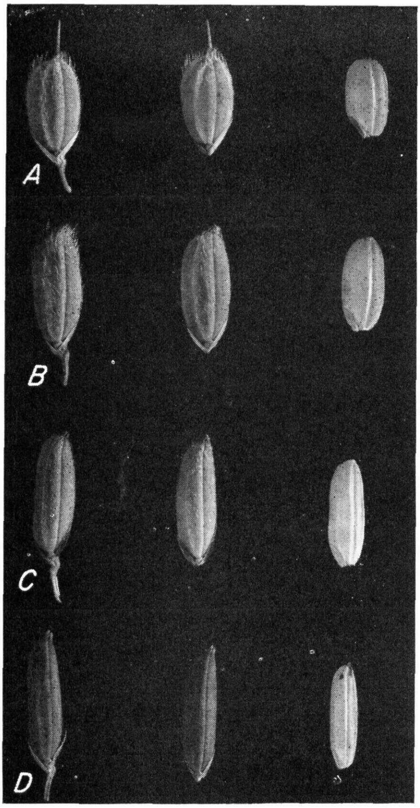

Figure 13.—*Spikelet, seed, and kernel of (A) Caloro, short grain; (B) Blue Rose, medium grain; (C) Fortuna, long grain; (D) Rexoro, long slender grain rice.*

The varieties grown in the Southern States may be classed as early, midseason, and late. The early-maturing varieties require about 120 to 139 days from seeding to maturity, the midseason varieties about 140 to 155 days, and the late-maturing varieties 156 days or more.

The number of days required from seeding to maturity varies with the variety and the date of seeding. Rice sown relatively early, in March or April, requires a longer time to mature and usually produces higher yields than that sown later. Not all varieties, however, have

the same capacity to shorten the growing period when sown late. For example, at Crowley, La., Blue Rose, when sown March 15, matured in about 189 days, but sown May 15, it matured in about 135 days, or a difference of 54 days; whereas, Early Prolific, sown on the same dates, matured in 141 and 122 days, respectively, or a difference of only 19 days.

Varieties that materially lengthen or shorten their growing periods when sown from early to late in the spring include Blue Rose, Arkrose, Kamrose, Acadia, Asahi, and Cody. Varieties that show less variation in the length of the growing period when sown from early to late in the spring include Zenith, Early Prolific, Magnolia, Prelude, Rexoro, Texas Patna, Bluebonnet, Fortuna, and Nira.

Varieties, such as Blue Rose, that have a tendency to mature at nearly the same time regardless of the date of seeding are not well suited for growing on a large acreage, because the entire crop is likely to be ready for harvest at about the same time. These varieties, however, are well suited for late-seeding. Such varieties as Zenith, Early Prolific, and Magnolia can be used to advantage on large acreages, because they mature relatively early if sown early and later if sown late. Hence, the harvest period can be extended over a longer period by seeding on different dates.

The short-, medium-, and long-grain varieties mentioned in the following paragraphs are reasonably well adapted for growing in the Southern States. None is resistant to all of the diseases present in the rice areas, but most of these varieties are resistant or moderately resistant to one or more of the most common diseases. Most of the varieties grown have relatively stiff straw and yield well under favorable conditions. When harvested at the proper time and carefully dried and stored, rice of good milling quality is produced. Some of the varieties grow taller than is desirable for harvesting with a combine, but all can be combined and dried satisfactorily. Lodged rice is much more difficult to combine than standing rice, and tall varieties when lodged are more difficult to harvest than lodged short-strawed varieties. Pickup reels on binders and combines are helpful in harvesting lodged rice.

Short-Grain Varieties

The short-grain rice varieties grown in the Southern States and California are largely of Japanese origin. They are hardy and produce relatively high yields of good milling quality. These characteristics tended to make them popular with both farmers and millers. Now, however, medium- and long-grain varieties are preferred by growers and consumers. In the 5-year period 1944–48 [2] only about 2.5 percent and in 1950 about 0.75 percent of the total annual acreage in the three Southern States was sown to short-grain rices. Rice of this type is relatively more important in Arkansas than in Texas or Louisiana.

The principal short-grain rices grown are Cody and Caloro, early-maturing varieties; and Asahi, which, when sown during the normal seeding period, is a midseason variety.

[2] From data compiled by the Rice Millers Association, New Orleans, La.

The seeds of Cody, Asahi, and Caloro are short and broad, and the hull is light yellow (straw-colored). The stalks and leaves often are fairly green when the crop is mature. Asahi and Caloro are normally partly awned (bearded), but the awns are short and usually break off in threshing. The leaves of Asahi and Caloro are narrow, and the stalks are relatively small and pliable. They tiller freely and, when grown on rich land, produce heavy panicles, the weight of which may cause the plants to lodge. They do not shatter easily. These three short-grain varieties are reasonably well suited for combining, but they are reported to be more difficult to dry artificially than are the principal long-grain rices.

Medium-Grain Varieties

The principal medium-grain varieties grown in the Southern States are Zenith and Magnolia, followed by Arkrose and Kamrose, which are grown largely in Arkansas. These varieties usually yield and mill well and for this reason are popular with both rice growers and millers. Zenith and Magnolia have relatively stiff straw and fairly wide leaves, whereas Arkrose and Kamrose have more pliable straw and narrower leaves. The four varieties tiller freely and yield well when grown on reasonably fertile soil. Zenith and Magnolia are early, whereas Arkrose and Kamrose are midseason varieties. In the 5-year period 1944–48, 50 percent, and in 1950, 39 percent of the rice acreage in the Southern States was sown to medium-grain rices, as compared with 70 percent in 1942. The medium-grain varieties are reasonably well adapted for combining, but they are reported to be more difficult to dry than are most long-grain rices.

Long-Grain Varieties

Owing to the shape of the kernels, long-grain rices are more likely to be broken in milling than are the short- and medium-grain types. Long-grain varieties of good quality, however, usually command a premium over short- and medium-grain types in both rough- and milled-rice markets. This apparently represents the consumer's preference for long-grain types that retain their shape and are reasonably tender when boiled. The higher prices paid for rough and milled long-grain rices and the fact that they are relatively easy to combine and dry, have in recent years led to a marked increase in the acreage seeded to the long-grain types. In the 5-year period 1944–48, 48 percent, and in 1950, 61 percent of the total rice acreage in the Southern States was sown to long-grain varieties as compared to 28 percent in 1942.

The better quality long-grain varieties include Rexoro, Texas Patna, Bluebonnet, Nira, Rexark, and Century Patna. These varieties are more resistant to diseases, produce higher yields, and are of better table quality than the old long-grain varieties. In Arkansas, Prelude yields well and has been extensively grown. Rexoro and Texas Patna, owing to late maturity, cannot be grown safely in Arkansas, but the other varieties listed are adapted for growing in all three States. Rexoro, Texas Patna, Bluebonnet, Nira, Rexark, and Century Patna are reported to be easier to combine and dry than are the other commercial long-, medium-, and short-grain varieties.

SEED AND SEEDING

Importance of Good Seed

Good seed rice should be well matured and free from red rice (red kernel coats), immature, hulled, or broken seed, seed of other varieties, and weed seeds. Mixtures of varieties differing in kernel size or maturity are particularly objectionable. Uniformity in ripening and in kernel size are more important in rice than in wheat, because the value of rough rice is based largely on the percentage of whole kernels obtained in milling, whereas wheat is ground into flour. Seed containing straw- or black-hulled red rice (red kernel coats) should be avoided, because the red grains spoil the appearance of the milled rice. Seed of low germination may result in uneven stands, uneven ripening, and often in lower yields of poor milling quality. The use of the combine-drier method of harvesting has resulted in a shortage of good seed rice that is free of mixtures and of straw- or black-hulled red rice. This fact is appreciated by growers, and the demand for pure seed of high-germination capacity exceeds supplies.

Seed Treatment

Seed treatment improves the stands of rice, especially in periods unfavorable for germination. Before seeding, most of the seed is now treated by the slurry method, either with Arasan at the rate of 1 ounce or with Ceresan M at the rate of ¼ to ½ ounce per bushel. Cuprocide at the rate of 1 ounce per bushel is also recommended.

CAUTION.—Ceresan M is poisonous, and reasonable care should be taken to avoid breathing the dust or its fumes or having it come in contact with the skin, especially if the skin is moist, as it will cause blisters. The treating should be done in the open air or in a well-ventilated place. If dust is present in the air, a dust mask should be worn over the nose and mouth. The sleeves should be rolled down, and gloves may be used to cover the hands and wrists. Treated seed should not be used for feed or food.

Since some persons are allergic to the chemicals used, necessary precautions should be taken in applying any treatment, even though the chemical is not highly poisonous.

Method of Seeding

Rice usually is sown with a grain drill (fig. 14, *A*), but broadcast seeders also are used. Of the two methods, drilling is preferred by some growers because it places the seed at a uniform depth under conditions that usually are more favorable for germination. Less seed is required to obtain good stands of drilled than of broadcast rice, but drilling is more expensive. If rice is drilled too deep, the seedlings may have difficulty in emerging, especially if a crust forms on the soil surface after rains. Rice often is broadcast by endgate seeders on rough dry seedbeds, then harrowed, and the land often flushed (irrigated).

Airplanes (fig. 14, *B*) are used to some extent for water seeding of rice on old grassy lands or on land on which it is difficult to prepare a

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good seedbed. The method of airplane seeding varies with the soil, water, and weather conditions in the respective States. The land may be flooded and then harrowed in the water with a spike-tooth harrow prior to seeding (fig. 15). Usually soaked seed is broadcast on the water by planes. The water is either held on the land continuously or the fields are drained shortly after seeding and resubmerged in time to control the growth of grasses and weeds. Observations indicate

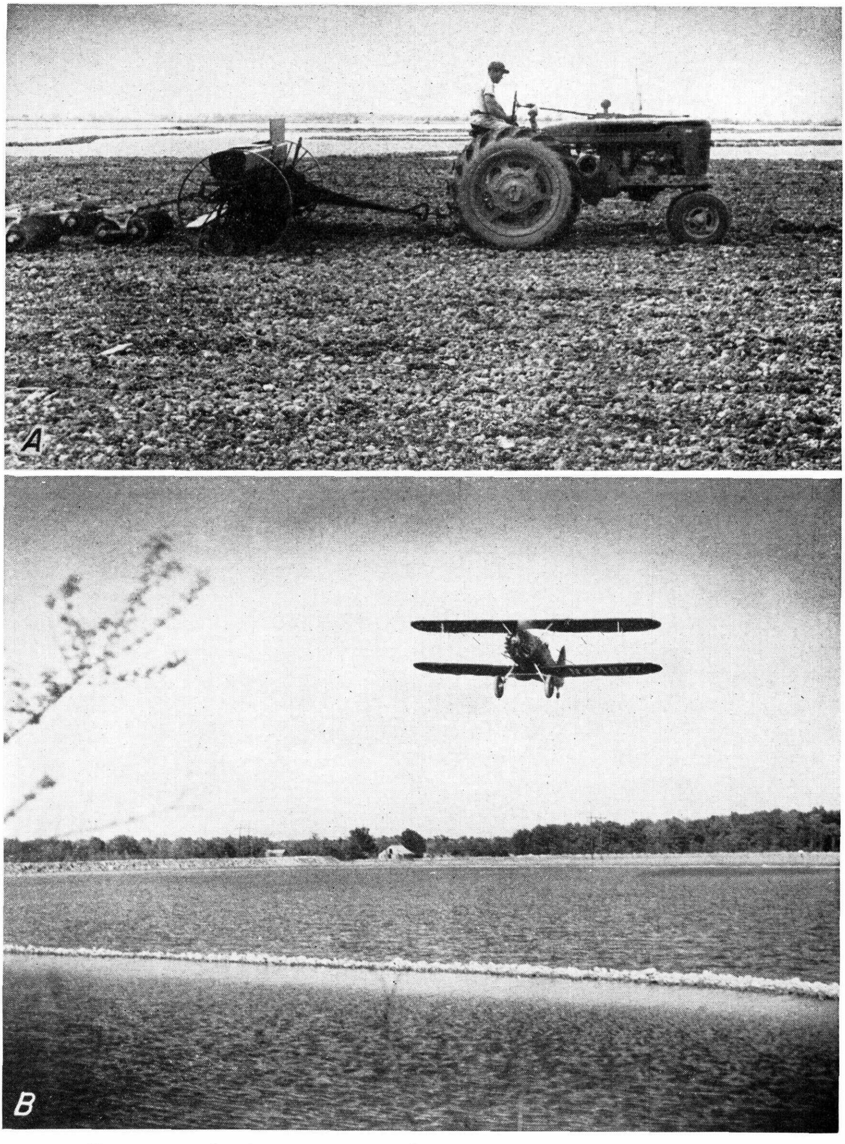

Figure 14.—*Seeding rice with a grain drill (A) and with a plane (B).*

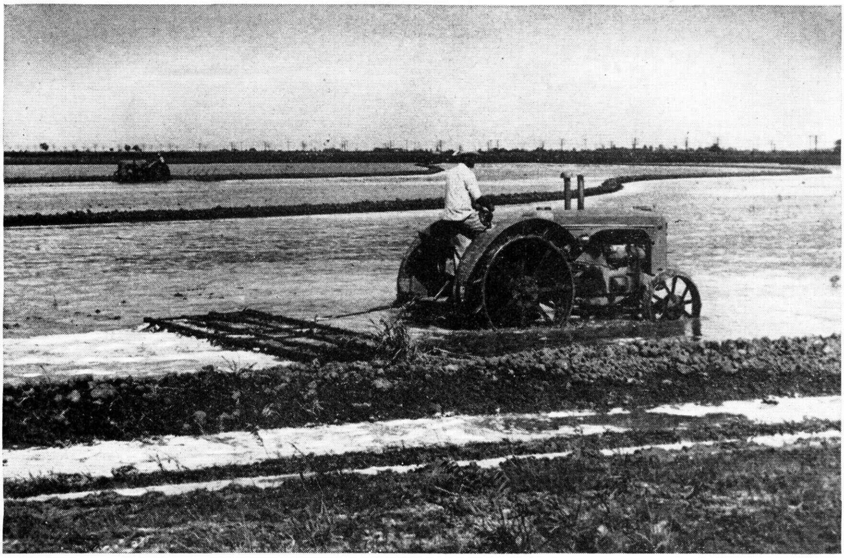

Figure 15.—*Harrowing flooded land prior to seeding.*

that water-seeded rice is usually freer of weed seeds, grass seeds, and red rice and also matures more uniformly than that grown in the usual way. An adequate supply of irrigation water and good drainage are required with this method of production.

Time of Seeding

Rice usually is sown in the Southern States from April 1 to May 30, but if conditions are favorable some seeding is done in March and as late as June 30, in some instances. Rice germinates more quickly when sown late in the spring when temperatures are high than when sown earlier. Seed of early-sown rice is subject to rotting because of the lower temperatures and less favorable conditions for germination and rapid growth. Under such conditions poor stands may result. Late seeding also has an advantage in that the weeds that have started growth can be killed by cultivation before seeding. Results from date-of-seeding experiments indicate that there is a comparatively long period in the South during which rice can be sown and still produce satisfactory yields. It is possible and often advisable to spread the seeding of certain varieties so that the harvest can be extended over a longer period.

Rate of Seeding

Under ordinary conditions 90 to 100 pounds of recleaned viable seed sown with a drill or 110 to 140 pounds sown broadcast is sufficient to give good stands. Under favorable conditions rate-of-seeding experiments with drilled rice indicate that 80 pounds of seed per acre usually is sufficient to give good stands. The rate of seeding should be sufficiently high to produce stands that are thick enough

to help check weed growth and also to prevent late tillering, which often results in irregular ripening and rice of inferior quality. Less seed is required when rice is sown late than when it is sown early in the spring, for conditions are more favorable for germination late in the season. Many other factors, such as seed size and quality, condition of the seedbed, fertility of the soil, and the variety, enter into determination of the proper rate of seeding.

Depth of Seeding

In fields sown with a drill, seed should be placed 1 to 2 inches deep. Usually there is less danger of rotting from shallow than from deep seeding, especially if it is necessary to flush (irrigate) the land after seeding to induce germination. Rice may be sown somewhat deeper on light than on heavy soils. Shallow seeding is preferable to deep seeding on a rough seedbed or a fine mellow seedbed that is likely to crust after rains. Surface crusts may be broken by a light harrowing or by irrigation to permit the emergence of the seedlings.

FERTILIZERS

Prairie soils that have been cropped to rice for years usually are deficient in organic matter and nitrogen. Yet in fertilizer tests conducted in the early thirties, the application at seeding time of phosphoric acid and nitrogen alone and in combination usually failed to increase yields materially. This was caused in part by the fact that fertilizers when applied on or near the surface of the soil at seeding time stimulated the growth of grasses and other weeds more than that of the rice plants. Since about 1940, however, with better cultural, irrigation, and weed-control practices, the results of experiments in which nitrogen, phosphorus, and potash have been applied singly and in combinations at rice experiment stations and on outlying fields in the South have, except for potash, usually shown consistent increases in yields.

The application of nitrogenous fertilizers to ricelands usually results in more vigorous plant growth. Under some conditions it also hastens heading and ripening. Heavy applications may, however, result in lodging, in increased sterility, and in plants that are more susceptible to diseases.

In Arkansas yields on old ricelands have been increased by the application 6 or 8 weeks after seeding of a complete fertilizer, 4–8–4, at the rate of 500 pounds per acre. Since about 1940, however, top dressing with 40 pounds or more of nitrogen per acre on the dry soil before the first or second flooding has materially increased yields. Top dressing with nitrogen on dry soil has given more consistent increases in yields than have applications made at seeding time (fig. 16). The application of phosphorus and potash singly and in combination has failed to increase yields materially except for phosphorus on lands on which hay crops have been harvested. Potash is used, however, by some growers to help control stem rot.

In Louisiana complete fertilizers drilled with the seed or about 2.5 inches below the seed have given marked increases in rice yields. On the lighter colored fine sandy loam and silt loam soils the ap-

plication at seeding time of the 6–9–6, 8–8–8, or 6–10–4 grades at the rate of 300 pounds or more per acre have increased yields. On the darker colored silty clay loam and clay loam soils the application of 4–12–8, 5–10–5, or 6–10–4 grades at the rate of 200 to 300 pounds per acre have given marked increases in yields. Drilling fertilizers about 2.5 inches below the seed has given larger increases in yields than drilling it with the seed. Top dressing with 20 to 30 pounds of nitrogen on drained land before the rice reaches the booting stage has materially increased yields when 200 pounds per acre of 4–12–8 or 5–10–5 grades was drilled below or with the seed. Top dressing alone, however, has not been so effective in increasing yields in Louisiana as has complete fertilizers drilled below or with the seed.

Figure 16.—*Application of fertilizers as a top dressing by plane.*

In Texas nitrogen applied to heavy clay lands at the rate of 80 pounds per acre at seeding time or as a top dressing 30 to 70 days after seeding, depending upon the variety, has materially increased the yields of rice. On clay loam and loam soils the application of nitrogen at the rate of 80 pounds plus 40 pounds of phosphoric acid per acre at seeding time, or as a top dressing 30 to 70 days after seeding, has been recommended. On fine sandy loams a combination of 40 pounds each of nitrogen and phosphoric acid an acre applied at seeding time, or as a top dressing 30 to 70 days after seeding, has given marked increases in yields.

Ammonium sulfate and cyanamide are probably the most commonly used forms of nitrogen fertilizers. Ammonium nitrate and anhydrous ammonium also have been used to advantage. Cyanamide should not be applied with the seed or as a top dressing on seedling rice damp with dew, because it may interfere with germination or injure moist plants. In Texas grassy lands that are seeded to rice and in need of phosphorus should receive phosphoric acid applied as a top dressing

30 to 60 days after seeding, for best results. On such lands the application of a 16–20–0 grade at the rate of 200 to 300 pounds per acre as a top dressing has been used to advantage.

Thus, in each of the three Southern States fertilizers may be used to advantage under certain conditions, but environment, soils, and drainage are so varied that specific recommendations for all conditions are not advisable. Local tests should determine whether applications of nitrogen, phosphorus, potash, or all three are profitable.

Probably the best way to insure high yields is to maintain an adequate supply of organic matter in the soil and to supplement it with needed commercial fertilizers. The decomposition of organic matter will assist in liberating the plant-food elements already in the soil, improve the physical texture of the soil, and tend to provide for proper aeration of the roots by creating conditions favorable for the percolation of water into the soil. These are the conditions under which the crop usually responds best to the applications of fertilizers.

IRRIGATION

Rice is grown in essentially the same way as other small grains, except that the land on which the crop is grown is submerged for 60 to 90 days or more during the growing season. Applying water as soon as the crop is old enough to withstand submergence and maintaining the water at a constant depth are very important in rice production. Normally, when rice seedlings reach a height of 4 to 6 inches the land is submerged to a depth of 1 to 2 inches (fig. 17, *A*). As the plants grow taller, the depth of water is gradually increased until it reaches 4 to 6 inches (fig. 17, *B*). During the rest of the growing season or until the land is drained prior to harvesting, except for special reasons, the water should be held on the land at a depth of about 5 inches. To maintain a constant depth additional water should be applied to replace that lost by evaporation, transpiration, and seepage.

It is often not necessary to flush (irrigate) the land to germinate the seed. Germination, however, should be induced as soon after seeding as possible, in order to get the crop up ahead of weeds and grasses. When it is necessary to irrigate for this purpose the land should be drained promptly after seeding or the seed is likely to rot. From 33 to 45 inches of water, depending on the locality, is normally required to produce a rice crop, and of this amount about 11 to 15 inches is supplied by rainfall during the growing season.

DRAINAGE

The fact that rice is grown for 60 to 90 days or more on submerged land does not mean that good surface drainage is not essential. Good surface drainage is as necessary for successful rice culture as is a dependable supply of fresh irrigation water. Without good drainage it is difficult to prepare satisfactory seedbeds, to obtain good stands, or to produce satisfactory yields. Also the fields must be drained and dried prior to maturity and the harvesting of the crop. Unless land is fairly well drained it is difficult to dry it sufficiently before harvest so it will support tractors, combines, binders, and other machinery used in harvesting operations. Harvesting costs on poorly drained

Figure 17.—A, A submerged field of young rice, and B, a field of rice 6 to 8 weeks after submerging the land.

land often are much higher than on well-drained land. The loss of grain in harvesting is also greater, as it is practically impossible to operate the harvesting machinery on poorly drained land so as to save the entire crop.

Usually the land should be drained when the rice is fully headed and the heads are turned down and ripening in the upper parts. This stage ordinarily is about 2 weeks before the crop is mature, but the time to drain varies with the soil type, rice variety, and drainage system.

WEEDS

Rice is grown under conditions that are very favorable for the growth of aquatic (water-loving) and semiaquatic weeds. If not eradicated promptly such weeds increase rapidly, soon practically take possession of the fields, reduce yields, and reduce the value of the threshed product.

Weeds possess unusual vigor and usually produce an abundance of seeds, which often have the ability under certain conditions to lie dormant in the soil for years. Weeds are difficult to control, once they become established. The best method of controlling them, therefore, is to prevent them from becoming established in fields by the use of good cultural and other control practices and timely irrigation.

Weed seeds are spread by irrigation, drainage, floodwaters, wind, livestock, and machinery and by sowing weedy seed. The spread of weeds is encouraged by permitting them to grow and produce seed on levees, on ditchbanks, and in uncultivated corners of fields. Weeds can be kept under control by constant effort in preventing their propagation and spread and by carefully spraying broadleaved weeds with 2,4–D. Care should be taken not to use too much 2,4–D, as it may reduce tillering and delay the harvest appreciably.

CAUTION.—All forms of 2,4–D are deadly to most of the broadleaved crops and, therefore, must be used with utmost care in the vicinity of crops like cotton, tomatoes, potatoes, beans, and tobacco or near valuable trees, shrubs, and ornamental plants. Spray equipment that is to be used later for other chemicals should be cleaned thoroughly after using 2,4–D. Satisfactory cleaning usually can be accomplished with a 1-percent (2 teaspoonfuls per quart of water) solution of household ammonia. The solution should remain in the equipment, including hose and nozzles, for 24 hours. Then the equipment should be thoroughly rinsed with clean water.

The use of 2,4–D to control broadleaved weeds in rice fields is now a common practice. The recommendations are to use from ¼ to 1¼ pounds of 2,4–D (acid equivalent) per acre. The rate used depends upon the age of the seedlings when treated and the products used. As spraying usually is done with airplanes, the volume of material required must be low. Three to fifty gallons of liquid per acre should be sufficient to give uniform foliage coverage. The sodium or amine salts of 2,4–D are generally recommended for spraying rice in preference to the ester formulations of 2,4–D, which are more dangerous to use adjacent to susceptible crop plants.

The reaction of rice seedlings to 2,4–D depends upon the age, probably the variety, and the amount and kind of 2,4–D used. A small quantity of the chemical may kill very young seedlings. Seedlings 3 to 4 weeks old are, however, less sensitive, and ¼ to ¾ pound of 2,4–D per acre may be used with only slight seedling injury on well-irrigated, fertilized, and drained land. Fields are usually submerged in from 4 to 5 weeks after the seedlings emerge. A good time to apply 2,4–D for the control of Mexican weed, curly indigo, and indigo (common weeds in rice fields) is 2 or 3 weeks after the fields are submerged. At this time the rice seedlings are from 6 to 8 weeks old, and the use of ½ to 1 pound (acid equivalent) per acre usually

kills the weeds, with little injury to the rice. For treating still older rice, 1 to 1¼ pounds (acid equivalent) of 2,4–D per acre may be needed to control weeds. During treatment, the water should be relatively shallow in order to expose the weeds to the chemical.

For more complete information on the use of chemical sprays see Farmers' Bulletin 2005, Using 2,4–D Safely.

The most common and troublesome weeds in the rice fields of the South are red rice, Mexican weed, curly indigo, tall indigo (coffeebean), barnyard grasses, and certain sedges.[3]

Red rice, which is one of the most serious weed pests in southern rice fields, differs from white rice in having a red kernel coat instead of the usual brown color. It belongs to the same species as white rice, and red-kerneled varieties are extensively grown in some countries. Red rice is as nutritious as white rice, but in most markets milled white rice is preferred by consumers. The chief objection to red rice is that in milling rough rice containing some red grains, which often are smaller than those of the white, it is frequently necessary to mill so closely in order to remove the red kernel coats that considerable white rice is broken. The milled product has an unattractive appearance unless the red kernel coat is removed. The presence of red-streaked kernels in milled rice lowers its market value.

Red rice is spread largely, if not entirely, by using seed that contains red grains. Seed of the red rice variety that is most troublesome in the Southern States shatters readily, and the seed, like that of other weeds, has the ability to retain its viability for several years when buried in the soil. Unless eradicated promptly it may practically take possession of fields.

The common southern red rice variety can be distinguished from commercial rice by its sparse, open, drooping head (panicle), which has few grains on the branches. In growth it is more spreading than are the commercial varieties. Scattered plants in commercial fields can be pulled, but this is not practicable when red rice plants are numerous. The most effective control measure is to avoid seed containing red rice and thus prevent its introduction on clean land.

There is some natural crossing in rice, and, because all the plants of the first hybrid generation and three-fourths of the second generation have red kernels, the proportion of red rice rapidly increases when crossing between red and white varieties occurs. The short-, medium-, and long-grain red rice seeds and kernels, which are at times observed in rough and brown rice and in fields, probably originated as a result of natural crossing between the cultivated varieties of these types and red rice. Some red rice types that appear as a result of natural crossing are seemingly identical in all respects with the cultivated varieties except for the red kernel color. It is not possible or practicable to locate and pull these plants in fields.

DISEASES

Several diseases attack the rice plant in the Southern States, but only a few are of economic importance. Farmers' Bulletin 1854, Diseases of Rice, contains detailed discussion of the diseases listed

[3] *Oryza sativa, Caperonia palustris, Aeschynomene virginica, Sesbania exaltata, Echinochloa crusgalli* and *E. colonum,* and *Cyperus* spp., respectively.

here. Seedling blight, caused by a fungus,[4] attacks young seedlings in warm, moist weather before the land is flooded. Other fungi[5] destroy the tissues of the roots, and the seedlings fail to emerge or die after emerging. Early-sown rice seems to be more subject to injury by these fungi than that sown late, owing to the fact that late-season conditions are more favorable for rapid germination and vigorous seedling growth than the early season conditions; hence, the rice seedlings are less subject to attack by fungi.

Stem rot is caused by either of two species of fungi,[6] both of which may be found on the same plant. Small, black, discolored areas appear on the leaf sheaths at the surface of the water or slightly above. The small, black spot on the leaf sheath enlarges, and eventually the tissues of the sheath and stem are largely destroyed and the affected plants may lodge. If the disease develops early it may prevent the plants from setting seed. In severely infected fields yields are materially reduced by failure of the plants to set seed or by lodging of the plants that have set seed. Further loss results from harvesting a crop that is lodged and because of the poor quality of the rice produced by lodged plants. The development of the disease may be checked and the losses caused by it reduced by draining the water from fields about 6 weeks before maturity and then keeping the land wet but not submerged.

Brown leaf spot and narrow brown leaf spot[7] cause reduction in yield and in the quality of the rice. When a plant is severely affected, the healthy leaf area is so materially reduced before the plant matures seed that the grain often is irregular in shape, light in weight, chalky, and of poor milling quality. Varieties differ in susceptibility to the leaf spot diseases. The best control measure is to use resistant varieties.

Straighthead is a physiological disease and is not caused by a fungus or bacterial organism. As the name indicates, heads of affected plants remain erect and fail to set seed well. Badly diseased plants may even fail to head. Leaves of affected plants are darker green and stiffer than normal, and they remain green after the normal plants have matured. The roots of affected plants are usually large, and small branch roots and root hairs are often lacking. The disease apparently is caused by organic materials that, in certain stages of decay, interfere with normal root development. Often it can be controlled by draining the land about 4 to 5 weeks after it has been submerged and allowing it to dry out thoroughly before resubmerging.

The white tip disease is caused by a seed-borne nematode.[8] Affected plants have chlorotic white leaf areas and tips, twisted boots, stems, heads, and deformed seed. In severely affected plants the heads often fail to emerge fully from the leaf sheaths. Yields often are reduced, and the quality of the rice is inferior to that of normal plants. Losses caused by white tip can be reduced by seeding early in the

[4] *Sclerotium rolfsii* Sacc.

[5] *Helminthosporium oryzae* Breda de Haan, *Curvularia lunata* (Wakk.) Boed., and *Trichoconis caudata* (Appel & Str.) Clements.

[6] *Leptosphaeria salvinii* Catt. and *Helminthosporium sigmoideum irregulare* Cralley & Tullis.

[7] Caused by *Helminthosporium oryzae* Breda de Haan and *Cercospora oryzae* Miyake, respectively.

[8] *Aphalenchoides oryzae* Yakoo.

spring and by growing tolerant varieties. Seed fumigation with methyl bromide has been suggested as a possible control measure.

INSECTS

The rice plant is attacked by several insects that reduce the yield and lower the grain quality. More detailed information is given in Circular 632, Rice-Field Insects, and Farmers' Bulletin 1906, Insect Pests of Stored Rice and Their Control, which can be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Rice stink bugs,[9] both nymphs and adults, insert their long, slender, strong beaks through the hull and suck the inner part of the kernel. When the grain is in the milk stage, they may suck out the entire contents, leaving an empty seed coat. Grains of rice in the dough stage that have only a part of their contents removed by the bugs are known to the trade as pecky rice. Such kernels are often broken during the milling process. They may also be discolored, owing to the entrance of molds that follow bug damage. Each year stink bugs cause some reduction in yield and lower the quality of some of the rice produced in Arkansas, Louisiana, and Texas. Late-maturing varieties are the most severely attacked because of the presence of large numbers of the bugs late in the season. The adult stink bugs can be destroyed by plowing under heavy grasses in which they hibernate.

Stems of rice plants are attacked by the larvae of the sugarcane borer and the rice stalk borer.[10] These larvae, or worms, bore into the stem, weakening the plant so that lodging and even breakage may occur. Often the injury causes the head to turn white and the plant fails to bloom and set seed. The losses caused by these borers are difficult to measure, but in some fields losses have been estimated at more than 200 pounds of rice per acre. Varieties having large stems appear to be most susceptible to injury. The number of overwintering borers may be greatly reduced by fall plowing of the stubblefields, by heavy pasturing, or by dragging and winter submergence of the rice stubble. Corn and sugarcane should not be grown near the rice fields.

Although the sugarcane beetle [11] is known in Louisiana principally as a pest of sugarcane, it also injures rice in all the southern rice-producing States, both before and after irrigation. This black robust beetle gnaws the young plants just below the surface of the soil, usually causing them to wither and die. Many plants in a row are sometimes killed in this way. Rice plants growing on the levees may be injured throughout the season by this beetle. The beetles will not attack rice so long as the surface of the soil is covered with water. Treatment of the seed with kerosene or coal tar has provided protection during the dry growth period prior to submergence.

The rice water weevil [12] in the larval stage, commonly called the root maggot, feeds on the roots of the rice plant. The roots may be

[9] *Solubea pugnax* (F.).
[10] *Diatraea saccharalis* (F.) and *Chilo plejadellus* Zinck., respectively.
[11] *Euetheola rugiceps* (Lec.).
[12] *Lissorhoptrus simplex* (Say).

cut off and in some cases killed, so that the development of the plants is retarded. This insect causes little injury to the rice crop in Louisiana, but in Arkansas it is considered a major pest of rice and may reduce yields as much as 30 percent. Well-timed drainage, before the weevil larvae can cut off the roots of the rice plants, has been recommended as a control measure.

HARVESTING

Rice should be harvested when the kernels in the lower part of the heads are in the hard-dough stage (fig. 18). At this time the kernels in the upper parts of the heads are fully developed, ripe, and free from chalky opaque areas and should mill well. At this stage of development the standing rice grain usually contains from 25 to 20 percent moisture. Rice harvested before it reaches this stage of maturity is likely to have a relatively high percentage of chalky, lightweight kernels that do not mill well. If the rice is harvested after this stage, the loss in some varieties from shattering may be increased, and, owing to the probability of checking of the kernels, the yield of head rice (whole kernels) is also likely to be reduced.

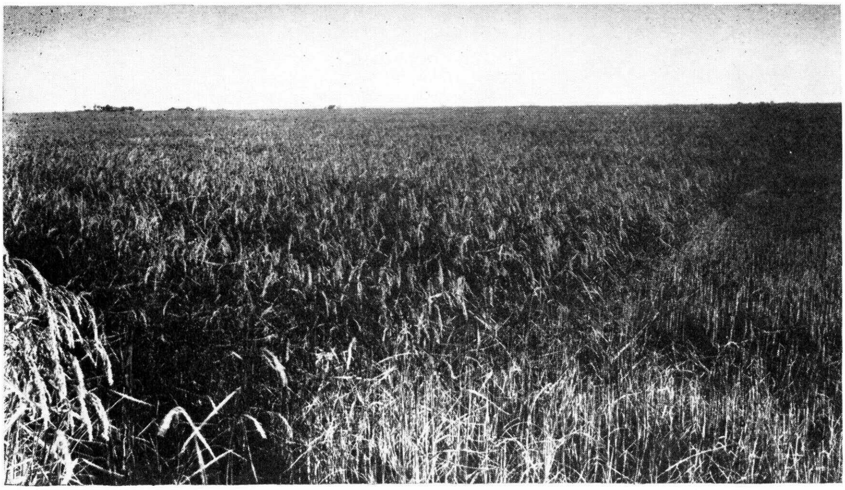

Figure 18.—*A field of mature rice ready for harvesting.*

Rice is harvested with combines (fig. 19, *A*) or rice binders drawn by tractors (fig. 19, *B*). Both self-propelled and tractor-drawn combines, ranging in size from 6- to 14-foot cuts, are used. Self-propelled combines are used in opening up subfields and fields by cutting the first swath next to the levees and around the fields. Then both types can be used to complete the harvesting of the subfields or fields. Approximately 90 percent of the rice crop in the Southern States is harvested with combines.

Rice that is to be combined and dried artificially should be harvested before it is fully ripe or before the moisture content of the grain is less than 20 percent, as the kernels may check and be of in-

ferior milling quality. The moisture content of the combined rice is reduced gradually to 13 or 14 percent in artificial driers.

In harvesting the combined rice is elevated into a bin or hopper on the combine. When the ground is firm the filled bin is emptied or augered into dump trucks that haul it directly to the drier. On soft

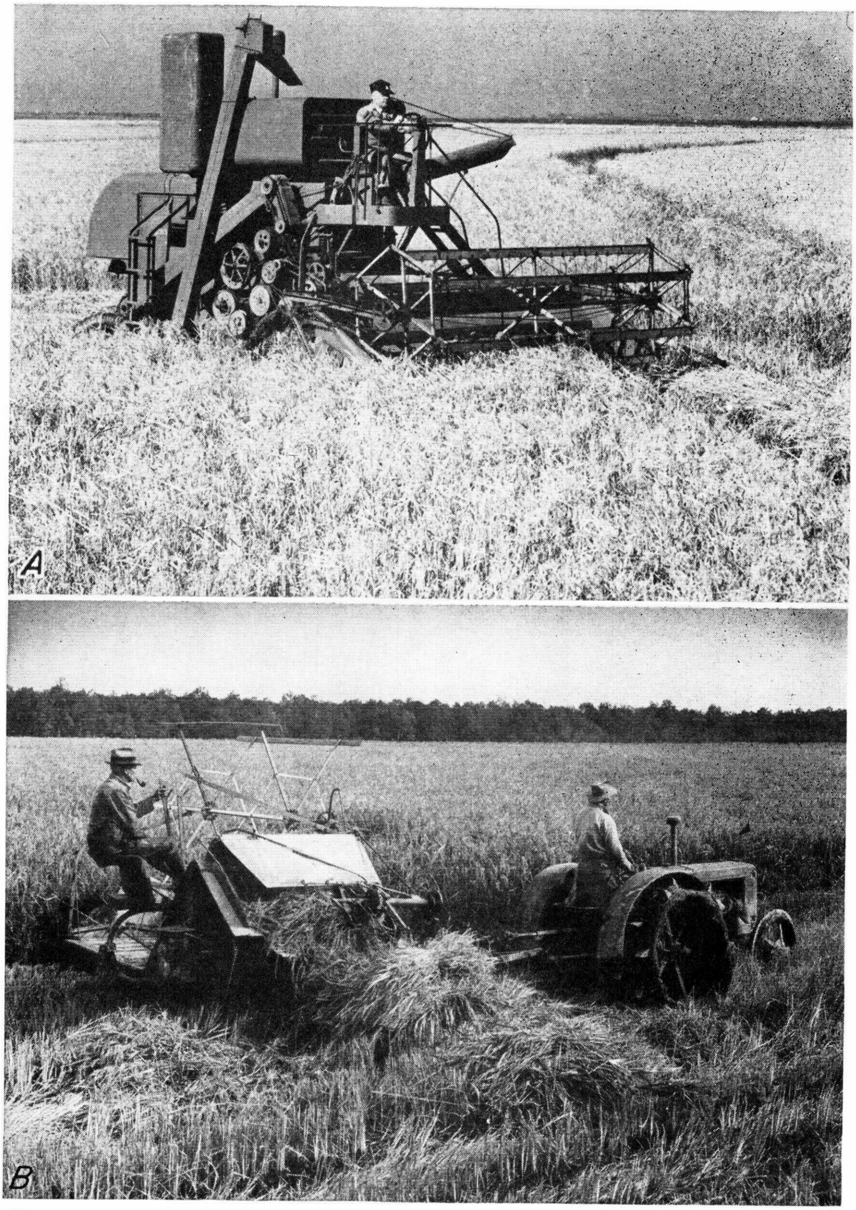

Figure 19.—*Harvesting rice with a self-propelled combine (A) or with a binder (B).*

land the bin is emptied into a rice cart or bed mounted on rubber-tired wheels or crawler tracks and drawn by a tractor, which hauls the rice to firm ground (fig. 20). The sides of the cart slope gradually to the bottom where a conveyor, usually driven by a power take-off from the tractor, elevates the rice into dump trucks that deliver it to the drier. Some carts are self-propelled.

Figure 20.—*Elevating rice from combine-bin into a rice cart.*

At the drier the rice is dumped into a receiving hopper and is elevated to the top of the drier, where it may pass through cleaning equipment into bins from which it passes by gravity or conveyors into the drier stands. Warm air, usually ranging in temperature from 100° to 130° F., is forced through the columns of rice moving downward through the drier stands, and the moisture content of the grain is reduced gradually. Depending upon the moisture content of the grain, the rice usually is passed through the drier two, three, or more times in order to dry it gradually to 13 or 14 percent moisture without injury to milling quality (fig. 21). Between runs through the drier, which take from 12 to 36 hours, the partly dried rice is stored in a bin, where the moisture content of the rice is equalized. This facilitates more efficient drying. The dried rice is stored in bulk in elevators or in sacks in warehouses (fig. 22). Some rice, especially for seed purposes, is dried in sack driers.

Rice harvested with a binder should be shocked promptly and in such a manner that the grain will be protected from rain and sun as much as possible while curing (fig. 23). Excessive moisture interferes with proper hardening, and alternate drying and wetting may result in checking of the kernels.

Rice cures well in shocks that are properly capped and provide for a free circulation of air. Usually 9 to 12 bundles, 1 or 2 of which are used as a cap, are placed in a shock. If the straw in the bundles is wet or too green, fewer bundles are placed in a shock.

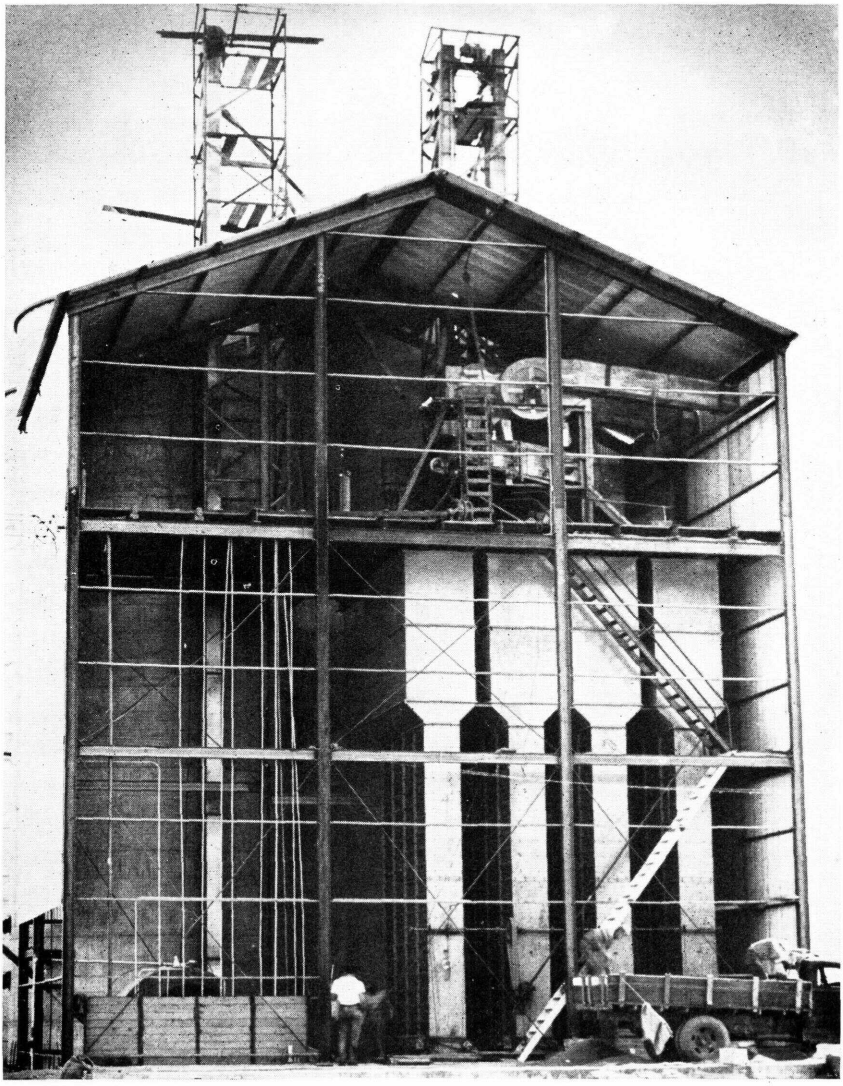

Figure 21.—*A rice drier.*

Rice is threshed after it has cured in the shock from 10 days to 2 weeks. The straw should be thoroughly dry and the grains hard. In threshing an effort should be made to prevent cracking of the grain, because this lowers the milling quality of the rough rice. The threshed grain is stored on farms or in public warehouses (fig. 24) until sold to mills, where it is prepared for market.

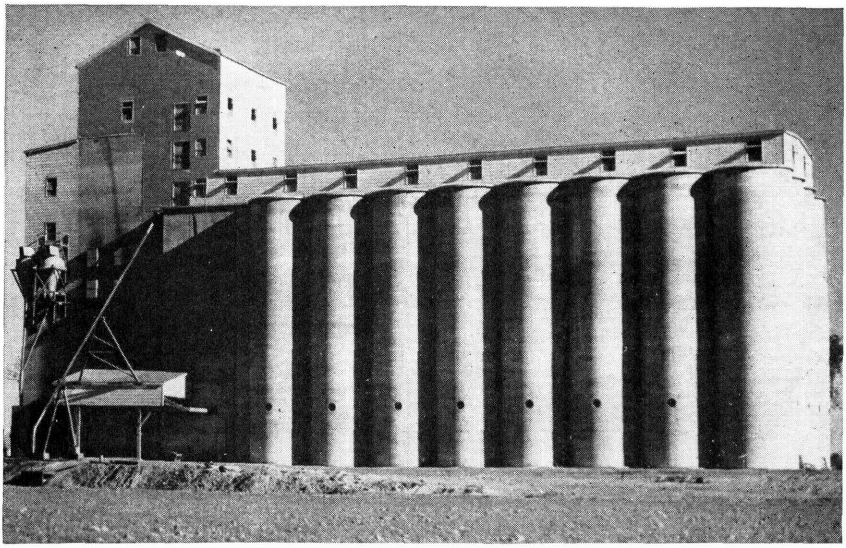

Figure 22.—*Rice storage elevator.*

Figure 23.—*A field of rice in the shock.*

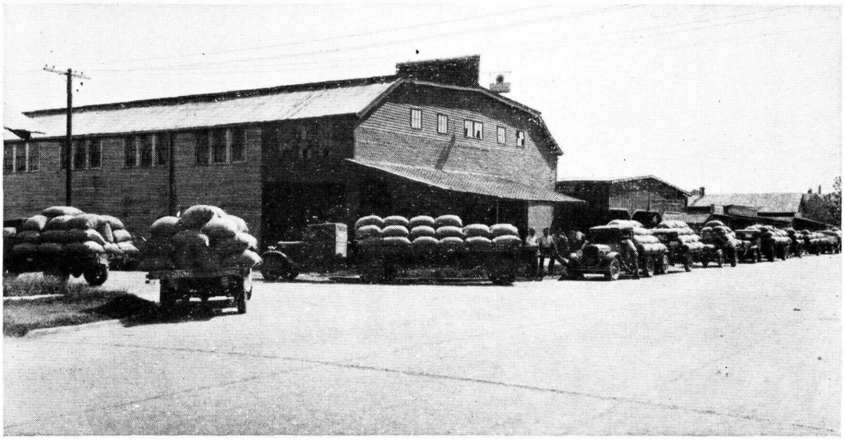

Figure 24.—*Trucks loaded with rough rice at a warehouse.*

MISSISSIPPI RIVER AND BAYOU TECHE DISTRICTS

In the 5-year period 1944–48 about 5,300 acres were sown annually to rice in the Mississippi River and Bayou Teche districts in Louisiana. The alluvial and "buckshot" soils adjacent to the Mississippi River are well suited for rice culture. Rice is being grown on a limited scale on soils of this type in Mississippi. Buckshot soil is dark in color and contains considerable clay. The river soils are more porous than the prairie soils and, hence, require more water to produce a crop. The land along the river usually slopes gradually from the river to the swamps, but in some places the slope is more abrupt, and in growing rice the levees must be placed rather close together. Nearly all the river land on which rice is grown has been previously divided by drainage ditches into long narrow strips, which extend from the river to the swamps. In growing rice these strips of land are divided into smaller checks by levees constructed at right angles to the drainage ditches.

The river rice crop is grown on land that has produced several crops of sugarcane or corn or on abandoned weed-infested plantations on which two or more consecutive crops of rice may be grown. The land usually is plowed in the winter, and in the spring the seedbed is prepared by disking and harrowing.

In this district the water used in the irrigation of rice is siphoned from the Mississippi River. When the level of the water is high, the water is siphoned over the levees, but when the water is low it is pumped either directly into the siphons or into small ponds on the riverbank, from which it is siphoned over the levees. In some years the river is so low that the cost of pumping is prohibitive and the crop is injured from lack of moisture unless heavy showers occur.

The same varieties are grown in the river sections as on the prairies, but the proportion of early-maturing varieties probably is larger. The rice is sown with endgate seeders at the rate of 120 to 150 pounds an

acre and is covered with a harrow. Seeding often begins the latter part of February. The fields, with few exceptions, are irrigated and drained after seeding to induce prompt germination and obtain good stands. After the seedlings emerge, the method of irrigation and harvesting is essentially the same as on the prairies.

In the river district weeds, which grow abundantly, are controlled either by hand pulling, mowing, or by spraying with 2,4–D.

The most objectionable weeds are the indigo, Mexican weed, several strictly aquatic weeds, and various grasses and sedges. Indigo is kept under control when the fields are in rice but is allowed to grow when the fields are not cropped, to assist in maintaining fertility.

The same diseases and insects attack rice here as in other parts of the State, but straighthead is usually more common and causes greater losses.

The part of Louisiana traversed by the Bayou Teche is generally referred to as the "Teche," or "Evangeline Country." The soil is less porous than that along the river, but it is not so impervious as the prairie soils. The method of irrigation is more like that followed on the prairies than that in use in the river district.

Until about 1889 the rice crop probably was grown as "Providence," or upland. Providence rice was grown on low areas enclosed by levees on the lower side to hold the water. Rainfall was depended upon to supply the water required to mature the crop. On the more porous soils the crop was often grown in rows and cultivated to control weeds.

In the 5-year period 1944–48 an average of 14,400 acres was sown annually to rice in the Teche district. The method of preparing levees and seedbed, and the varieties and seeding methods used in the Teche district are similar to those in the Mississippi River district. Seeding, however, usually is begun later in the spring. The fields seldom are irrigated to induce germination. The irrigation water is obtained largely by pumping from Bayou Teche. The crop is harvested in practically the same manner as on the prairies. The same weeds, diseases, and insects affect the crop as in the other rice-growing districts of the State.

UPLAND RICE

Upland rice has been grown on a small scale in the South Atlantic and Gulf States for many years. About 2,600 acres were grown in the United States in 1939, principally in South Carolina. The crop was grown on 1,120 farms with an average of 2.3 acres per farm. Total production was 44,000 bushels, or an average yield of 16.9 bushels an acre, as compared with 52 bushels for the irrigated crop grown in the four main rice-producing States.

Upland rice cannot be grown successfully on moisture stored in the soil prior to seeding. Therefore, a satisfactory yield depends upon favorable temperatures and a comparatively high rainfall that is well distributed during the growing season. Upland rice normally is grown only for home use, either for food or for livestock and poultry feed. The crop can be grown on soils of various types, but best results are likely to be obtained on soils that hold moisture well.

Upland rice varieties are apparently more resistant to drought than varieties grown on irrigated land. However, some of the less sensitive lowland varieties also can be grown with fair success under upland conditions. Gopher, an upland variety, is reasonably well suited for growing in the South. Because of the small acreage involved, little or no breeding work has been done on the improvement of upland varieties in this country.

The seedbed for upland rice should be well prepared in the same manner as for corn or cotton. The seed is sown in furrows on level land or in beds. It may be sown with a grain drill in rows of the desired width by closing certain feed holes, or it can be sown by hand in open furrows either in hills or drills and then covered.

Normally 12 to 36 pounds of seed is sufficient to sow an acre of upland rice in rows spaced 1½ to 3 feet apart. Sowing several seeds in hills, spaced from 6 to 12 inches apart in the rows, makes weeding easier and is a common practice in some foreign countries. Two or three cultivations and some hand hoeing usually are necessary to keep weeds under control. On the more fertile lands and following truck crops grown on heavily fertilized land, it should not be necessary to fertilize upland rice, but on the poorer soils the crop may be topdressed in the seedling stage with nitrogen at the rate of 20 to 30 pounds per acre.

Leaf spot diseases that occur on rice in the irrigated areas also attack the upland crop. These diseases when abundant reduce yields and lower the quality of the rice. Birds are especially fond of rice, and in isolated patches they often destroy large quantities by feeding on the grain when it is in the milk stage. They also eat the ripe grain if the crop is not harvested promptly. Insects attack upland as well as lowland rice.

Small patches of upland rice usually are harvested by hand, but larger fields may be harvested with binders or small combines. Rice harvested by hand or with binders should be allowed to dry on the stubble or in shocks before threshing. The crop should be threshed as soon as the grain is well dried. The crop can be threshed by flailing or with a small thresher. The threshed grain should be dried, cleaned with a fanning mill, and stored under dry conditions.

RICE MILLING

The kernel of rice as it leaves the thresher is enclosed by the hull, or husk, and is known as rough rice. A sack of rough rice weighs 180 to 225 pounds; a barrel, 162 pounds; and a bushel, 45 pounds. A crop of rice harvested with a binder yields about equal weights of rough rice and straw. The rough rice when milled yields about 63.9 percent of whole and broken kernels, 12.9 percent of bran, 3.7 percent of polish, and 19.5 percent of hulls. Some rough rice is used for seed and also as feed for livestock, but most of it is sold to millers, who prepare it for market (fig. 25).

In milling, the rough rice is first screened and fanned to remove trash, chaff, weed seeds, dried mud lumps, and light seeds. It is then conveyed to the hulling stones, which remove the hulls. From the hulling stones the mixture of hulled rice, rough rice, and hulls is

fanned or asperated and passed to paddy machines, in which the rough rice is separated from the hulled kernels. The rough rice from the paddy machines is returned to the stones for removal of the hulls.

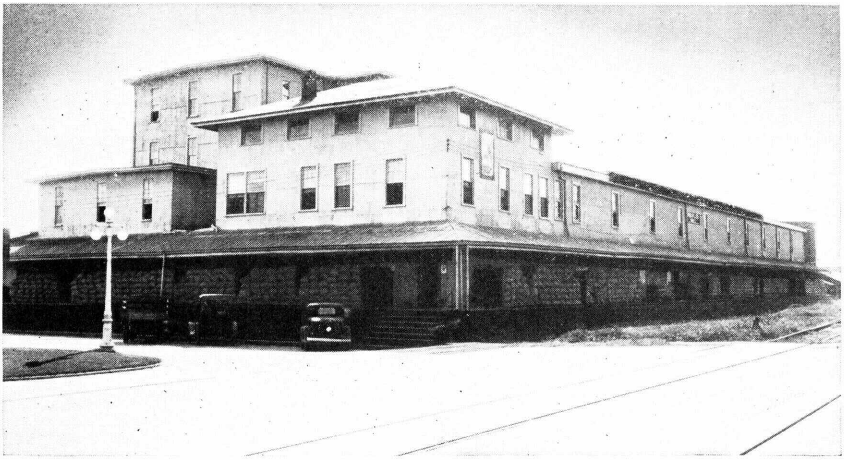

Figure 25.—*A rice mill in which the rough rice is prepared for market.*

The hulled kernels, known as brown rice, are conveyed to hullers, in which a part of the bran layer on the outside of the kernels and the germ are removed by friction. It is then passed through a second set of hullers and in some mills to a pearling cone also. From the second hullers and from the pearling cone the rice is returned to the bran reel for separation of the bran and rice. The rice may then be conveyed to the brush, in which the kernels are polished.

In the polishing process more of the bran and some starch cells are rubbed off and are separated from the rice by means of screens. The powder forced through the screens is known as rice polish. After polishing, the rice is screened and may be conveyed to a revolving cylinder (trumble), where it is coated with glucose and talc. The milled rice is then separated into grades, weighed, and bagged.

PARBOILING

Parboiling and related premilling treatments have long been used in India, Burma, Malaya, Ceylon, and elsewhere to improve the milling and nutritional quality of rice. Rice not parboiled before milling is usually referred to as raw rice. In this country active interest in parboiling began with the critical rice shortage that followed the outbreak of World War II.

Before parboiling, rough rice is soaked in hot, warm, or cold water for periods ranging from 2 to 72 hours. The soaked rice is then steamed, usually under pressure, for a few minutes, and after drying on floors in the sun or artificially it is milled in the usual way. The

methods of parboiling used in various countries differ a good deal, but all appear to have much the same gelatinizing effect upon the treated grain.

In the United States parboiling has been modernized and adapted to large-scale operations. Three plants producing "converted," "malekized," or "processed" rice were in operation in 1950.

Properly parboiled rice gives high mill yields of head rice (whole kernels), retains vitamins well, has improved cooking quality and high nutritive and keeping qualities, and is suitable for use in canned products. These are advantages of prime importance to rice producers, millers, dealers, and consumers in all important rice-producing and rice-consuming countries.

The disadvantages of parboiled rice are that it is not usually liked by consumers who are accustomed to eating untreated (raw) milled rice, owing to differences in the flavor, color, and consistency of the cooked product.

UTILIZATION

Unbroken and nearly whole milled kernels are known as whole, or head, rice. This product commands the highest price and is sold under several grades established by the United States Department of Agriculture or under private classifications, which are based largely upon type, luster, color, and size of the kernels. Milled nonglutinous rice is usually boiled for consumption. It is also used, however, as a breakfast food in the form of a cooked cereal and as prepared, puffed, flaked, and rice krispy products. Rice flour is also used.

Broken kernels are sold as "second heads," screening, and brewer's rice and are used as food, as feed for livestock, in making fermented beverages, and as a source of starch and flour. Rice starch is used in cosmetics, in laundries, in confections, in the sizing and finishing of textiles, and it can be used in making pastes, glues, adhesives, vinegar, acetone, and alcohol.

Bran consists of the kernel coats and the germ, with varying quantities of hulls. Bran free from hulls is the most nutritious and palatable of the rice feeds. Bran, however, often becomes rancid. Oil is extracted from rice bran, which improves its keeping quality. The polish contains less fat and protein, but more starch than the bran. Bran and polish are used as concentrated feeds for livestock. Polish may be used as food in the form of a thickening in gravies, in sauces, and in puddings, and as stuffing material in sausage, and also in the manufacture of buttons, soap, and oil.

Hulls may be used for fuel, packing material, bedding for poultry, insulating material, soil mulch, fertilizer conditioner, and as a filler for horse collars. Hull ash is used as a bleaching agent, as a filler for concrete and bricks, and as a source of sodium silicate, in making soaps and polishing and cleaning agents. Paper pulp and cellulose may be obtained from the hulls. The following products can be made from the cellulose: Cardboard, rayon, celluloid, and other plastics. Cellulose treated with sulfuric acid yields dextrin and glucose, which, on fermentation, produces ethyl alcohol. Cellulose treated with acetic acid forms cellulose acetate from which artificial silk, films, nonshatterable glass, plastics, and rubber substitutes may be derived.

Rice straw is used for feed. Where the crop is cut and threshed by hand and the straw retains its original shape, as it often does in some countries of the Orient, it is used in making mats, sacks, rope, sandals, brooms, hats, and coats; for thatching roofs; for hedges to protect young plants; and for fuel. It is also used as bedding for livestock, as a soil mulch, and as a fertilizer. Rice straw is also used in the manufacture of paper and cardboard and as a source of cellulose from which, as has already been indicated, many products may be derived.

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